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Mercury control costs drop

The control costs range from $3,810, to $166,000/pound mercury removed, and the increased cost of electricity is estimated to vary from 0.14 to 3.92 mills/kilowatt-hour.

The cost of controlling mercury from coal-fired power plants can be up to 50% less than the 1999 baseline estimates, according to an economic analysis from the U.S. Department of Energy (DOE). The new report, published today on *ES&T*'s Research ASAP website (DOI: 10.1021/es0617340), focuses on a well-known technology, activated carbon injection (ACI), and has sparked interest from electric utilities and environmental advocates who sparred over EPA's Clean Air Mercury Rule (CAMR) when it was released in 2005.

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The clock is ticking for U.S. coal-fired power plants in terms of installing technologies that will control mercury emissions.

"The clock is ticking for U.S. coal-fired power plants," in terms of developing the most effective strategies for responding to CAMR, writes Thomas Feeley and coauthors at DOE's National Energy Technology Laboratory (NETL). Coal-fired plants are the largest single source of mercury emissions nationally and emit 48 tons (t) of mercury annually, according to DOE.

The CAMR (*Environ. Sci. Technol.* **2005**, *39*, 232A–233A) requires power plants to control mercury emissions to achieve a nationwide reduction of 38 t beginning in 2010 and an additional

cut of 15 t by 2018. Required to do so under the Clean Air Act, EPA put off establishing mercury controls on utilities for as long as possible. The final CAMR includes a controversial cap-and-trade system, which allows power plants that reach emissions levels that are below their targets to sell emissions credits to other plants. Plants that purchase credits can use them to meet their emissions caps without reducing mercury.

Sixteen states have sued EPA over CAMR, charging among other things that because some plants won't control mercury, hotspots with high levels of mercury will develop or be exacerbated. Fifteen states have already finalized mercury control rules that are stricter than EPA's, and eight more states have tough mercury programs in the works, according to the National Association of Clean Air Agencies.

"The most significant message of the research is that the cost of controlling mercury is coming down," says Feeley. "While the results are promising, there are a number of issues that still need to be addressed," Feeley says. The results are based on relatively short-term field tests and not on long-term commercial demonstration runs.

ACI is a promising way to remove mercury from a plant's flue gas, technology experts say. In a typical configuration, powdered activated carbon is injected upstream of a particulate control device (PAC), either an electrostatic precipitator or fabric filter. The PAC adsorbs the mercury from the combustion flue gas and is subsequently captured along with the fly ash in the particulate control device the authors write.

DOE has been working on the development of mercury control technologies since the early 1990s, in anticipation of a mercury control rule, Feeley says. DOE's baseline cost estimate in 1999 was $50,000–70,000 per pound (lb) of mercury removed. EPA used this data when developing CAMR, according to technology and policy experts.

In the new *ES&T* paper, researchers developed an economic analysis of pilot test results from six small coal-fired power plants, in an attempt to provide the costs of reducing mercury at low (50%), mid (70%), and high (90%) levels. In 2004, they conducted 30-day pilot tests at plants ranging from 60 to 360 megawatts. These smaller plants are likely to need ACI to control mercury, while the larger facilities can rely on mercury reductions achieved as a co-benefit of controlling SO_2 and NO_x, Feeley suggests. The ACI technology was varied by using either a brominated PAC or untreated sorbent. And the plants used various kinds of low-rank or lower-heat-value coal.

The economic analysis shows that the costs of controlling mercury with ACI are as much as 50% less, plus or minus 30%, than what was predicted in 1999. The authors calculated costs ranging from $3,810 to $166,000/lb mercury removed. They also calculated the increased cost of electricity (COE), finding it varied from 0.14 to 3.92 mills/kilowatt-hour (kWh).

Western coal, long thought to be incompatible with ACI because of the coal's very low chlorine levels that result, after combustion, in high levels of elemental mercury, is shown to be a good fuel source for a plant with brominated ACI, says Mike Durham president of ADA-ES, Inc. a technology and chemicals speciality firm that participated in some of the pilots. Once the researchers impregnated powdered activated carbon with bromine, "We found we had very good results with western coals," he says.

Many experts agree that the cost figures in DOE's analysis are realistic. "The paper clearly illustrates what technology vendors and environmental groups have been saying all along, that this technology is relatively inexpensive and it's very efficient," says Martha Keating, associate in research with the Children's Environmental Health Initiative at Duke University School of the Environment and Earth Sciences. Keating helped developed EPA's assessment of mercury controls technologies in the 1990s. "The other thing that struck me is how dramatically the cost is dropping over time, and you see DOE saying that," Keating says. "From our perspective, this technology has been available and shown to be cost-effective since 2002," says Ann Weeks, an environmental attorney involved with the CAMR lawsuit against EPA.

Yet the debate over the costs of controlling mercury emissions continues. One electric utility officer, who did not want to be named and who works for a large U.S. company, stressed that the cost estimates have a wide range; are very plant specific; and depend on a variety of inputs, including the amount of carbon that is injected, the type of coal that is burned, the efficiency and size of the plant, and the electricity demand.

Table 3 in the *ES&T* paper shows that at 70% removal, including the cost of byproducts, the cost per pound of mercury removed ranges from $19,200 to $149,000, while the COE at 70% ranges from 0.90 to 3.92 mills/kWh. And 90% mercury removal wasn't achieved at three of the plants, the utility officer points out. "What I'm seeing is really such a large range of control costs that it makes it difficult for managers or operators to find where one of their plants would fit in. It's very hard to make a general statement of how much this will cost" at every plant, the utility representative says.

The paper is excerpted from a larger DOE report, DIOE/NETL/s Phase II mercury Control Technology Field Testing Program – Preliminary Economic Analysis of Activated Carbon Injection, which can be found at www.netl.doe.gov/technologies/coalpower/ewr/index.html. — CATHERINE M. COONEY